

Embolotherapy Using N-butyl Cyanoacrylate for Abdominal Wall Bleeding¹

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Purpose: We describe our experience with the use of N-butyl cyanoacrylate (NBCA) embolization of abdominal wall bleeding and we evaluate the clinical effectiveness of the procedure.

Materials and Methods: Embolization was performed in nine patients with abdominal wall bleeding. The sites of embolization were the left first lumbar ($n = 1$), left second lumbar ($n = 1$), right inferior epigastric ($n = 2$), left inferior epigastric ($n = 3$), right circumflex iliac ($n = 1$), and left circumflex iliac artery ($n = 1$). A coil was used with NBCA in one patient due to difficulty in selecting only a bleeding focus and anticipated reflux. NBCA was mixed with Lipiodol at the ratio of 1:1 to 1:4. Blood pressure and heart rate were measured before and after the embolization procedure, and the serial hemoglobin and hematocrit levels and transfusion requirements were reviewed to evaluate hemostasis and rebleeding.

Results: Hemostasis was obtained in six out of the nine patients and technical success was achieved in all patients. There were no procedure-related complications. Four out of the nine patients died due to rebleeding of a subarachnoid hemorrhage ($n = 1$), multiorgan failure ($n = 1$), and hepatic failure ($n = 2$) that occurred two to nine days after the embolization procedure. One patient had rebleeding. The five surviving patients had no rebleeding, and the patients continue to visit the clinic on an outpatient basis.

Conclusion: NBCA embolization is a clinically safe procedure and is effective for abdominal wall bleeding.

Index words : Abdominal wall
Arteries
Hemorrhage
Embolization, therapeutic

Abdominal wall bleeding occurs in traumatized patients or in patients after anticoagulation therapy with

the use of heparin or warfarin, and it also occurs as a complication of paracentesis, a femoral artery puncture for vascular intervention, or laparoscopic surgery (1 - 6). Even though conservative management is the treatment of choice unless bleeding is severe or the course is complicated by infection, abdominal wall bleeding often requires emergency or urgent treatment that includes manual compression, surgery, or interventional em-

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Received June 24, 2007 ; Accepted November 17, 2007
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bolotherapy (7 - 11). Manual compression is a noninvasive procedure, and is considered as the first choice for abdominal wall bleeding. However, the use of manual compression is limited as it may be difficult to achieve compression with sufficient pressure exactly on the bleeding foci, even though ultrasonography can assist the physicians to localize the bleeding foci (12, 13). Surgery is an invasive procedure, and surgeons prefer not to directly operate on patients without first attempting to use other methods, especially immediately after

patients have undergone surgery for some other reason. Recently, embolotherapy has been used in patients with bleeding at various sites with good outcomes (14 - 16). Embolotherapy for abdominal wall bleeding can be a good substitution procedure in place of manual compression and surgery as it is less invasive than surgery and is more precise than the use of manual compression.

Various embolic agents such as coils, gelfoam, polyvinyl alcohol particles or n-butyl cyanoacrylate

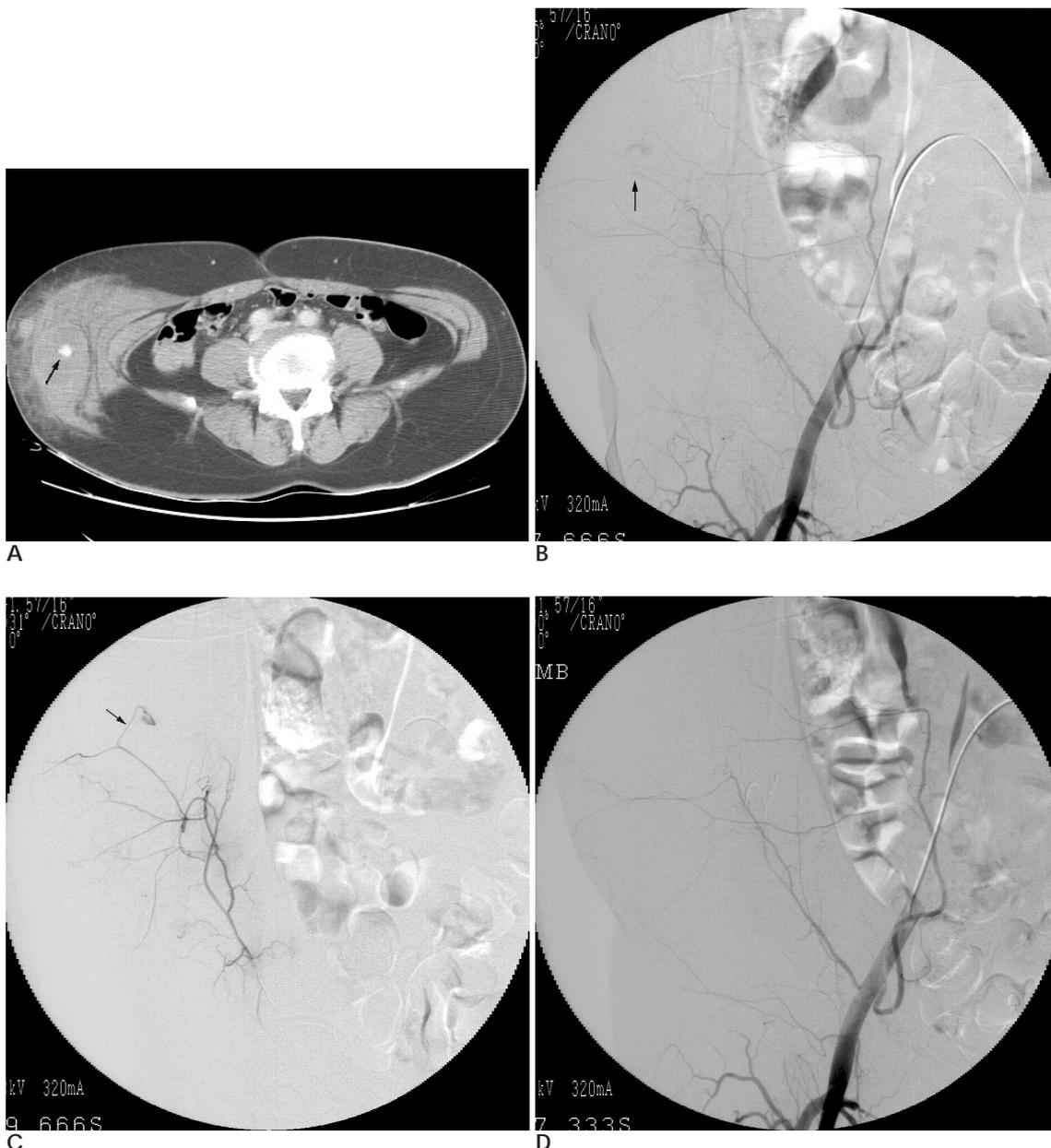


Fig. 1. NBCA embolization performed for abdominal wall bleeding (Patient No. 2).
A. A computed tomography scan demonstrates a bleeding focus (arrow) with a large hematoma at the right lateral abdominal wall.
B, C. A right external arteriogram and a selective right circumflex iliac arteriogram show a feeding artery (arrow) of the bleeding focus that originates from a branch of the right circumflex iliac artery.
D. An arteriogram after embolization demonstrates no further bleeding.

(NBCA; B. Braun, Melsungen, Germany) are used to control bleeding (17 - 20). Liquid embolic agents, that can cast bleeding foci might be more effective for abdominal wall bleeding as the vascular system in the abdominal wall is in the form of a network and may permit adjacent collateral channels to feed bleeding foci, even when a feeding artery is occluded. We have used NBCA for abdominal wall bleeding and have evaluated its clinical effectiveness in this retrospective study.

Materials and Methods

NBCA embolization was performed in nine out of 11 patients with abdominal wall bleeding between September 2003 and July 2007 (Fig. 1). We used gelfoam or a coil for two patients as it was not possible to approach the feeding branches sufficiently close to use NBCA. The nine patients that received NBCA embolization ranged in age from 18 to 78 years and the mean age was 50 years. The patient population included five men and four women. Embolization was performed in patients with hematoma at the right flank (one patient), left flank (one patient), right anterior abdominal wall (two patients), left anterior abdominal wall (four patients), and left retroperitoneum (one patient). A coil was used along with NBCA in one patient with a hematoma at the

right anterior abdominal wall due to difficulty in selecting only a bleeding focus, and due to anticipated reflux (Fig. 2).

Bleeding foci were located in the left first lumbar artery (one patient), left second lumbar artery (one patient), right inferior epigastric artery (two patients), left inferior epigastric artery (three patients), right circumflex iliac artery (one patient), and left circumflex iliac artery (one patient). The presence of a bleeding focus was confirmed on angiography. Underlying diseases are listed in Table 1.

This study was performed retrospectively with data obtained from medical records and telephone interview with the patients. The study received institutional review board approval and informed consent was obtained from patients and from patient families prior to undertaking the embolization procedure. Computed tomography images obtained prior to embolization were reviewed to determine the type of underlying disease, the presence of arterial bleeding foci and the location of the foci.

Blood pressure and heart rate were measured before and after the embolization procedure, and serial hemoglobin and hematocrit levels and transfusion requirements were reviewed to evaluate hemostasis and re-bleeding. A sudden stop of bleeding causes a change in

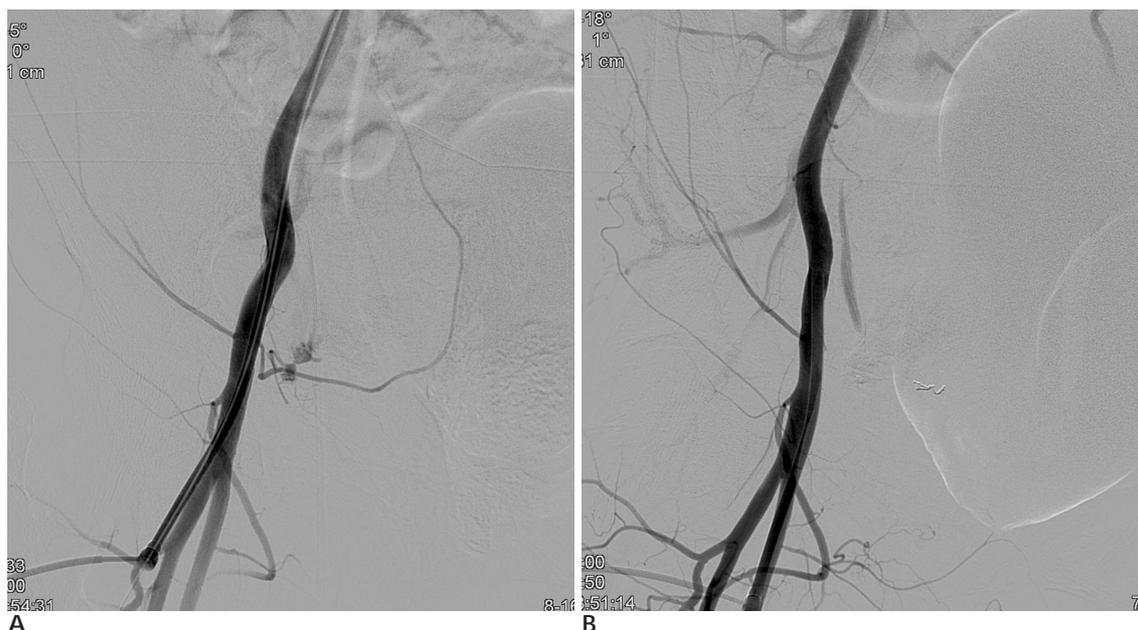


Fig. 2. NBCA embolization performed in combination with a coil (Patient No. 6).
A. A right external iliac arteriogram demonstrates contrast extravasation from the right inferior epigastric artery.
B. Due to difficulty in selecting only a bleeding focus and anticipated reflux, we embolized the distal part of the mother vessel with a coil and then injected the NBCA mixture at the proximal part of the vessel. A post-embolization angiogram shows no further extravasation.

Table 1. Clinical Findings in Nine Patients that Underwent NBCA Embolization

Patient No.	Age/ Sex	Underlying condition	Hematoma location	Bleeding foci	Embolic agents used	Ratio of NBCA and Lipiodol	Complications	Hemostasis	Rebleeding	Clinical follow-up
1	59/F	Subarachnoid hemorrhage, disseminated intravascular coagulation	Left flank	Left second lumbar artery	NBCA	1:1	No	Yes	No	2 days: death, rebleeding of subarachnoid hemorrhage
2	34/M	Fall	Right flank	Right circumflex iliac artery	NBCA	1:3	No	Yes	No	10 months: out patient visit
3	53/M	Infectious spondylitis, LC	Left retroperitoneum	Left first lumbar artery	NBCA	1:2	No	No	No	2 days: death, multiorgan failure
4	50/M	LC, ascites tapping	Left anterior abdominal wall	Left inferior epigastric artery	NBCA	1:2	No	No	No	2 days: death, hepatic failure
5	49/F	LC, ascites tapping	Left anterior abdominal wall	Left inferior epigastric artery	NBCA	1:4	No	No	Yes	9 days: death, hepatic failure, coagulopathy
6	59/F	Angina, coronary angiography	Right anterior abdominal wall	Right inferior epigastric artery	NBCA, coil	1:3	No	Yes	No	16 months: outpatient visit
7	49/M	Abdominal wall pain after exercise	Right anterior abdominal wall	Right inferior epigastric artery	NBCA	1:3	No	Yes	No	11 months: outpatient visit
8	78/F	Angina, coronary angiography	Left anterior abdominal wall	Left circumflex iliac artery	NBCA	1:3	No	Yes	No	10 months: outpatient visit
9	18/M	Repair of colostomy	Left anterior abdominal wall	Left inferior epigastric artery	NBCA	1:3	No	Yes	No	8 months: outpatient visit

Note LC, liver cirrhosis; NBCA, N-butyl cyanoacrylate

blood pressure and heart rate that can be an indicator of whether embolization was effective. Technical success was defined as bleeding foci no longer seen by the use of angiography after embolization, hemostasis was defined as bleeding that disappeared following angiographic and clinical evaluation and rebleeding was defined as bleeding that appeared again at angiographic or clinical evaluation.

Embolization Techniques

Angiography with the digital subtraction technique, abdominal aortography and selective arteriography were performed to detect bleeding foci. Arteriography in the lumbar artery, external iliac artery, inferior epigastric artery, and circumflex iliac artery were performed. A 5 Fr RH catheter or Davis catheter (Cook, Bloomington, IN U.S.A.) were used to select the lumbar artery and external iliac artery, and Microferret catheters and wires (Cook) or a Progreat catheter and

0.018 inch GT wire (Terumo, Tokyo, Japan) were used to select the inferior epigastric artery and circumflex iliac artery. The approach to the bleeding foci was performed cautiously to avoid triggering a vascular spasm where it impossible to inject the NBCA mixture or cause a delay in the procedure.

NBCA was prepared carefully without contact with ionic fluid or blood that causes liquid NBCA to polymerize and become solid. NBCA was mixed with iodized oil (Lipiodol; Laboratoire Guerbet, Roissy, France) at a ratio of 1:1 to 1:4, and the mixture provides radiopacity under fluoroscopy. A lower ratio (the use of additional Lipiodol) prolongs the time for NBCA to be solidify and is useful for embolizing bleeding foci that are difficult to approach and are located far from a microcatheter tip.

The NBCA mixture was injected into the bleeding foci after several test injections of liquid contrast agent to determine the injection power and to prevent a reflux to a

proximal feeding artery or an embolism to non-target organs. The use of test injections was useful even when the viscosity of the contrast agent and NBCA mixture were different and there was a difference in the injection power for the contrast agent and the NBCA mixture. Microcatheters were flushed with 5% or 10% glucose fluid before injection of the NBCA mixture.

Microcatheters were removed out of the body 1 to 2 seconds after injection of the NBCA mixture to prevent a cast of the NBCA mixture at the bleeding foci from being attached to the tips of the microcatheters. Follow-up angiography was performed after embolization.

Results

Technical success with the use of NBCA for abdominal wall bleeding was achieved in all nine patients even though a coil was added along with NBCA in one patient. Hemostasis was obtained in six out of nine patients and three patients did not show rise of a blood pressure and decline of heart rate before and after the embolization procedure. Procedure-related complications did not occur in any patients.

Patients underwent clinical follow-up for 2 days to 16 months with a mean duration of 6 months. Four out of nine patients died two to nine days after embolization. One male patient (Patient No. 3) had liver cirrhosis and underwent an L1 partial corpectomy and anterior fusion with the use of a mesh graft (T12-L2) due to infectious spondylitis (T11-L3) with a compression fracture (T11-L2). The patient was diagnosed with a large hematoma at the left retroperitoneum one day after surgery and the patient died of a multiorgan failure even though the bleeding focus, a branch of the left first lumbar artery, was embolized with the use of NBCA. Another female patient (Patient No. 1) had a hematoma at the left flank fed by a branch of the left second lumbar artery one day after a diagnosis of a subarachnoid hemorrhage and disseminated intravascular coagulation. The patient died due to rebleeding of a subarachnoid hemorrhage. The other two patients (Patient No. 4 and 5) had liver cirrhosis with a large amount of ascites, and a hematoma at the left anterior abdominal wall that occurred after ascites tapping. The patients died of a hepatic failure. Patient No. 5 had rebleeding at the left inferior epigastric artery, but the focus was different from the initial bleeding focus. The remaining five patients had no rebleeding and continue to be seen as outpatients.

Discussion

In this study, we used NBCA as an embolic agent for abdominal wall bleeding as we expected that the use of NBCA would provide better clinical effectiveness for hemostasis. The use of liquid embolic agents may be more favorable for a vascular system that is in the form of a network and may permit adjacent collateral channels to feed bleeding foci, even when a feeding artery is occluded (17).

NBCA is a liquid agent, and it is polymerized if exposed to ionic materials (21 - 24). NBCA polymerization can be predictably prolonged by the addition of Lipiodol. The prolongation may help NBCA reach bleeding foci far from a microangiocatheter tip as early polymerization causes NBCA to form a cast before its arrival at the bleeding foci. We mixed NBCA with Lipiodol in the ratio of 1:1 to 1:4, and ratios of 1:1 or 1:2 were adopted when the catheter closely approached the bleeding foci and ratios of 1:3 or 1:4 were adopted when it was not possible to reach the bleeding foci closely. Microcatheters were retracted from the body 1 to 2 seconds after the injection of the NBCA mixture. A quick removal was performed to prevent an NBCA cast at the bleeding foci from being attached to the microcatheter tip.

NBCA embolization can be performed effectively for various forms of bleeding. Kish et al. (17) reported that NBCA embolization was feasible and effective in patients with arterial bleeding from various etiologies and at various anatomic sites. The procedure was used to embolize brain arteriovenous malformations (AVMs), and the use of NBCA has been applied for various applications including craniofacial AVMs and extremity AVMs, hemangiomas in the mandible, arteriovenous fistulas with a long fistula tract, hypervascular tumors, varicocele, gastric varices, the portal vein before a partial hepatectomy, intractable epistaxis and acute arterial hemorrhage (25 - 33).

NBCA can be very useful in controlling arterial bleeding along with other embolic agents such as coils or gelfoam. Yamakado et al. (34) reported that a combination of the use of coils and NBCA was useful for a ruptured pseudoaneurysm that was difficult to embolize with the use of a coil alone. A patient in this study underwent NBCA embolization with a coil due to difficulty in superselecting a bleeding focus.

Currently, it is not difficult to detect a bleeding focus

and its origin in a patient with a hematoma at the abdominal wall with the availability of powerful imaging tools such as sonography, CT, and angiography. However, the presence of a hematoma could not be ascertained solely with clinical information and without the benefit of imaging. In this study, a hematoma at the anterior abdominal wall originated from the inferior epigastric artery or circumflex iliac artery, a hematoma originated at the flank from the circumflex iliac artery and lumbar artery, and a hematoma originated at the retroperitoneum from the lumbar artery. Although these findings may suggest possible origins of a hematoma in a clinical setting, it is not reasonable to generalize the use of these findings from this study.

Procedure-related complications were not found in any of the patients during this study. The amount of NBCA used in a patient was less than 0.25 mL when the mixing ratio was taken into account; therefore, side effects or complication due to NBCA itself may be minimal to disregard. However, the possibility of complications for NBCA embolization may be higher than for embolization with other embolic agents as NBCA is difficult to handle and familiarity with the NBCA embolization procedure can be time consuming.

A limitation of this study was its retrospective design. A small number of patients is another limitation.

In summary, NBCA embolization is a clinically safe and effective procedure for the treatment of abdominal wall bleeding, and the procedure may require the use of additional embolic agents for a satisfactory outcome.

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(n=2),	(n=3),	(n=1),
Lipiodol 1:1	1:4	가
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9	(n=1),	6
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